LEC measured capital input price rose slower than the measured capital input price for the U.S. economy, and the LEC labor input price rose faster than the labor input price for the U.S. economy. But neither of these differences can be properly construed as a change in long-term trends. As I discuss below, because they cannot be expected to continue, they cannot form the basis for a forward-looking regulatory policy.

In particular, the short-term difference in measured capital input prices reflects the fact that measured LEC capital input prices put a much larger weight on interest rates than measured U.S. capital input prices, and the fact that up until 1993 the post-divestiture period has been a time of declining interest rates. For my USTA study of LEC productivity growth, I used Moody's composite yield for public utility bonds as a proxy for the opportunity cost of capital for all LECs.[8] This yield fell from 14.03% in 1984 to 7.56% in 1993. It had risen to an average of 8.3% in 1994. We recognize that interest rates have declined somewhat from 8.3% but it is very unlikely that we will soon experience another period of significant decline as we did between 1984 and 1993.

A rise in interest rates, such as occurred in 1994, will cause a short-term input price difference in the opposite direction. Because short-term differences in one direction tend to be offset by subsequent short-term differences in the other direction, the inclusion of an input price growth

[8]Since the yield on public utility bonds reflects the cost of debt, but not equity, and since the cost of equity is typically higher than the cost of debt, this proxy will tend to understate the full opportunity cost of capital to the LECs. Moreover, since the cost of debt has recently fallen relative to the cost of equity, this proxy has declined relative to the full opportunity cost of capital to the LECs.

differential term or "W factor" in the price cap offset based on recent short-term fluctuations in input prices is likely to be in the wrong direction. Therefore, the best estimate of the expected input price growth differential is the long-term differential of zero, not the prospective use of the 1984-1992 differential as advocated by Dr. Selwyn and DRA witness Renaghan.[9]

In his attempt to justify the prospective use of the 1984-1992 input price growth differential, Dr. Selwyn makes a number of incorrect statements. First, his interpretation of the Bush/Uretsky analysis from Appendix F of the FCC's First Report and Order in CC Docket 94-1 is incorrect.[10] Bush and Uretsky specifically focus on the 1984-90 period and were seeking the actual input price growth differential for this period:[11]

> "...we reach a finding in this Appendix specifically with respect to the period 1984-1990, because this is the period that is relevant for purposes of corroborating the findings of the recalculated "Frentrup-Uretsky" study that the X-Factor during the period 1984-1990 was 5.0 percent."

In fact, Dr. Selwyn's quote of the Bush/Uretsky analysis on pages 38-39 of his testimony leaves no doubt that the issue is the appropriate input price growth differential for just that period: "...we believe that the input price differential for the 1984-1990 period should be based on data from that period."[12] The existence of a short-term 1984-1990 input price differential is not in dispute. However, there is no basis for using that short-term differential to project a similar pattern starting in 1996.

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[9] Testimony of T. M. Renaghan, Investigation No. 95-05-047, September 8, 1995, p. 5-7.
[10] Selwyn, p. 38.
[11] C. Anthony Bush and Mark Uretsky, "Input Prices and Total Factor Productivity," CC Docket 94-1, April 7, 1995, Appendix F, p.2, fn. 7.
[12] Bush and Uretsky, p. 14.

Second, Dr. Selwyn states that had I used long-term input price series consistently in both my TFP study and in the X factor calculation, the TFP result would have been roughly 5.5%, and he states that the FCC came to the same conclusion in its analysis.[13] He is wrong on both counts. Dr. Selwyn has confused the calculation of an historical rate of TFP growth with the establishment of an X factor. To calculate an historical TFP growth rate, one must use actual prices for the time period being analyzed. In order to correctly calculate TFP for the 1984-1993 period, one must use actual 1984-1993 prices. This is what I did in my TFP analysis. The TFP number of 5.5% derived by Dr. Selwyn is not based on actual prices and, therefore, is meaningless.

In establishing an X factor, one must use the most relevant historical evidence for predicting the future. As I have stated many times, basing expectations of future input price growth solely on an arithmetic average of volatile input price growth rates for the 1984-1993 period does not adequately address the problems of input price volatility and anomalies in the cost of capital for the telephone industry and U.S. economy. Therefore, one should use the long term historical trends in input price growth for setting the input price component of the X factor. Regarding his claim that the FCC came to the same conclusion, nowhere in its decision does the FCC suggest that I have inconsistently used input prices in my TFP calculations, nor does it conclude that a consistently measured TFP growth rate would be 5.5%.

[13] Selwyn, p. 46.

Third, Dr. Selwyn observes that the changes in input prices reported in my January 1995 TFP update "... narrow the gap between LEC and economy-wide input price growth rates for the 1984-1992 period." He goes on to state that "Since an increase in LEC TFP (which would normally follow from an increase in LEC input prices) would be contrary to USTA's financial interests, the new study appears also to incorporate other revisions whose effect is to leave the overall LEC TFP results essentially unchanged..."[14]

Dr. Selwyn's conclusion is based on a false assumption. He has assumed that in spite of data revisions, the total input cost for the LECs remained fixed. This is not the case: there were revisions that altered total cost as well as input prices. Thus, the changes that were made in LEC input prices do not imply changes in the quantity of LEC total input and correspondingly LEC TFP. In order for input price adjustments to have an offsetting impact on the LEC quantity of total input, the economic cost of total input must be known beforehand. While the economic cost of LEC labor and materials, rents, and services inputs are known ahead of time, the economic cost of capital is not. This means that total economic cost is not known until the price and quantity of total input have been computed. In such a situation, adjustments to input price lead to adjustments in economic cost, not adjustments in input quantity as mistakenly asserted by Dr. Selwyn.

[14] Selwyn, pp. 47-48.

4. Conclusion: The Most Appropriate Basis for Determining the X Factor is the Long-Term TFP Growth Differential with no Adjustments for Input Prices

The key in developing a forward-looking X factor is finding the best predictor of X--i.e., determining its expected value. In both the case of the TFP growth differential and the input price growth differential, the best prediction is the long-term historical value of the differential. For the TFP growth differential, the long-term value has remained stable over time at about 2 percent, and shows no signs of increasing. For the input price differential, the long-term value is zero and is subject to short-term fluctuations around this trend. Short-term fluctuations in one direction are likely to be followed by short-term fluctuations in the other direction. This is illustrated in Charts 4 through 6.

Chart 4
Average Telephone Industry and U.S. Economy Input Price Growth, 1948 - 1992

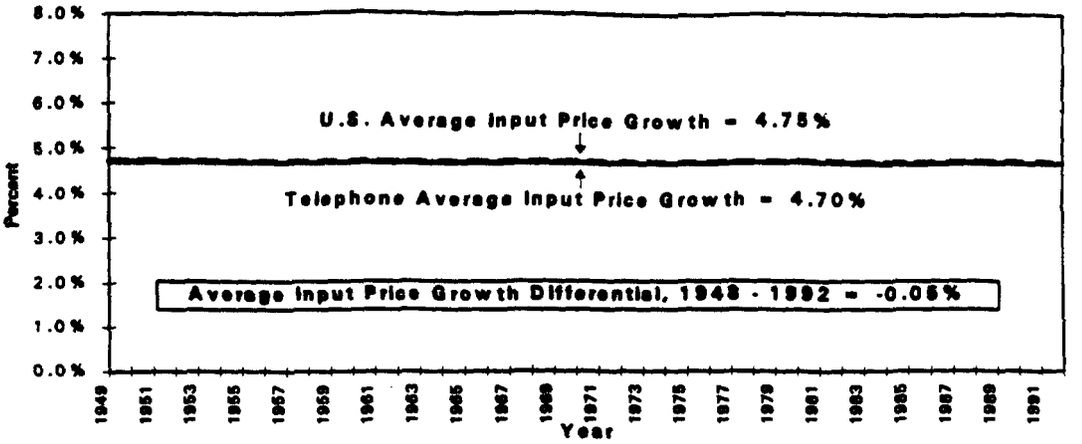

Chart 5
Input Price Growth Differential, 1948 - 1992

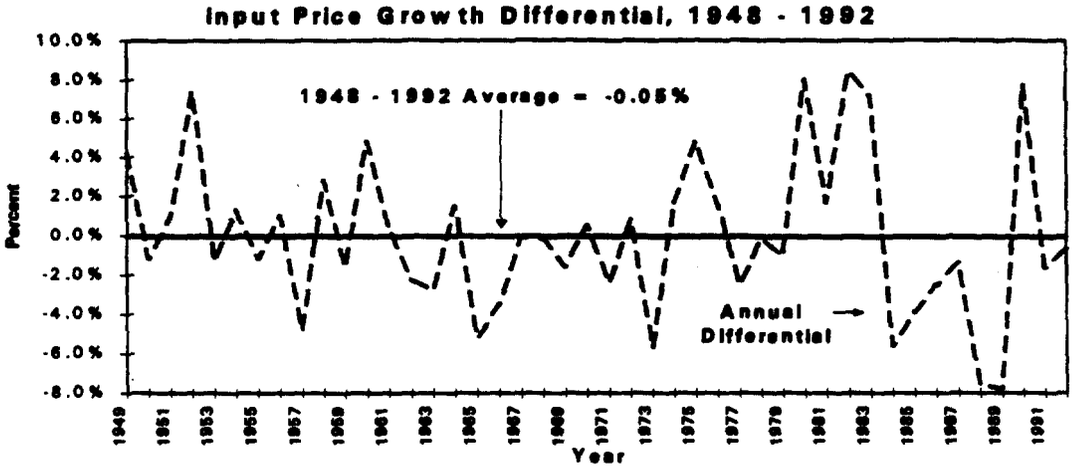

Chart 6
Input Price Growth Differential, 1984 - 1992

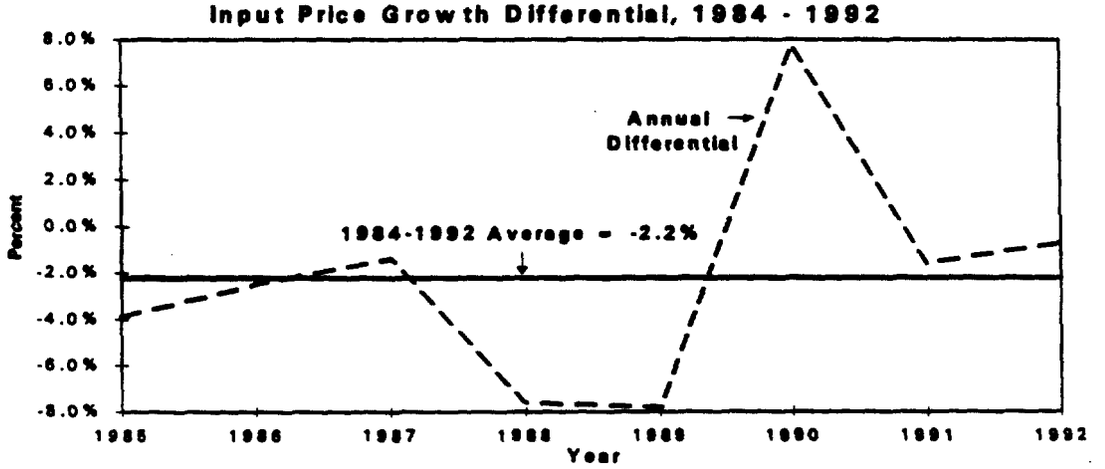

Chart 4 illustrates that the long-term average growth rates of telephone industry and U.S. economy input prices is almost identical, resulting in a long-term differential of 0.05%. Chart 5 shows the long-term differential and the annual values of the differential. It can be seen that there is substantial variability of the annual values around this long-term trend. Chart 6 illustrates that there was a great deal of annual volatility around the average 1984-1992 input price growth differential of -2.2%. As noted above annual values of the differential range from -7.8% to +7.7% during this period. The volatility of this series is so great that observed differences cannot be statistically distinguished from a difference of zero, meaning there is no statistical basis for using an observed short-run input price growth differential as a projection of expected future trends.

In summary, if the GDPPI-X price cap formula is retained for Pacific Bell, the most appropriate X factor is the long-term TFP growth differential of 2 percent. It has remained stable over time and has shown no signs of increasing.

Case No.: I.95-05-047
Exhibit:
Witness: Gregory M. Duncan
Date:

GTE CALIFORNIA INCORPORATED

TESTIMONY OF DR. GREGORY M. DUNCAN

Q. Please state your name and your business address.

A. My name is Gregory M. Duncan. My business address is 40 Sylvan Road, Waltham, Massachusetts 02154.

Q. By whom are you employed and in what capacity?

A. I am employed by GTE Laboratories, Inc. ("GTE Labs") and work within its Department of Economics and Statistics. I am a Staff Scientist with responsibility for developing, proposing and conducting research, as well as supervising the research of the other economists and statisticians at GTE Labs.

Q. What is GTE Labs?

A. GTE Labs is the central research and development facility for GTE. Its mission is to provide technical leadership to GTE business units, including GTE California, by conducting research and development activities in areas which will enable the various GTE business units to understand and utilize new advancements in technology. This service involves providing the management of the GTE business units with appraisals of technical trends, systems analyses, and economic assessments to insure the incorporation of technical and economic awareness in the management planning and decision process.

GTE Labs maintains academic ties with many prestigious universities to ensure that GTE stays on the

[redacted]

600, approximately 500 have Ph.Ds and many hold or have held teaching positions at Harvard, Massachusetts Institute of Technology (MIT) and Boston University. I myself have taught on the faculty of Boston University.

Q. Please describe your educational background and work experience.

A. I received a M.A. in Statistics in 1974 and a Ph.D in Economics in 1976 from the University of California, Berkeley. Beginning in 1975, I taught in the Economics Department and Statistics Program at Northwestern University in Evanston, Illinois, where I was an Assistant Professor of Economics and Statistics. My teaching responsibilities included Demand and Production Theory, Econometrics and Statistics, and graduate level Time Series and Discrete Choice Analysis courses. I also conducted research on demand and production, as well as in time series and discrete choice analysis, which appeared in refereed journals. I left Northwestern in 1979 to join the faculty at Washington State University, where I served as a Professor of Economics and of Statistics. My research continued in demand theory, production analysis, time series, discrete choice analysis and applications, as well as in other topics. During that period, I was one of the first Associate Editors of the academic journal Econometric Theory. Since that time, I have published many refereed papers in demand analysis, production analysis, and consumer and firm behavior.

I joined GTE Labs in 1987. I currently do a great

deal of internal consulting within GTE Corporation, which has exposed me to all facets of the telecommunications industry, including specifically, forecasting and demand analysis. I have worked closely with the Demand and Forecasting group within GTE Telephone Operations over the last seven years on a variety of demand analysis issues ranging from developing a forecasting system using state-of-the-art time series procedures to assisting in developing robust regression procedures.

Q. Have you testified before this Commission in the past?

A. Yes. I testified for GTE California Incorporated (GTEC) in Case No. I.87-11-033, Phase III Implementation Rate Design (IRD).

Q. What is the purpose of your testimony?

A. The purpose of my testimony is to recommend a productivity offset factor for use in the price cap mechanism in the event that the Commission chooses to retain the "x" factor as part of the price cap mechanism.

Q. Are you aware of studies which address computation of an appropriate productivity factor for the telecommunications industry?

A. Yes.

Q. At this time, do you recommend any particular study and in its findings regarding appropriate productivity factors?

A. Yes. My recommendation is to adopt the productivity

factor established in the study entitled "Productivity of the Local Telephone Operating Companies" by Christensen, Schoech and Meitzen ("the Christensen study"). I endorse both the analysis and results of this study. The most recent update of this study concludes that the proper telecommunication productivity factor is 2.1 percent.

Q. On what basis do you endorse the Christensen study?

A. First, Dr. Christensen, along with Professors Dale Jorgensen (at Berkeley and Harvard), Daniel McFadden (at Berkeley and MIT), Lawrence Lau (at Stanford), and Irwin Diewert (at Chicago and University of British Columbia) and their students, invented most of the production, cost and productivity methods which are used today. Among these methods are the total factor productivity methods, but also, index number theory, that is, the correct way of measuring input and output price changes. These methods are properly applied in the Christensen study.

Second, Dr. Christensen is one of the most prolific and highly regarded researchers in the area of production and productivity measures. Indeed, he is one of the most cited and well respected authors in the economics literature. Dr. Christensen is a theoretical and applied econometrician of the first rank.

Q. Have you personally reviewed the Christensen study?

A. Yes.

Q. What are your opinions as to the relevance of this study to the present NRF Reform proceeding?

A. To the extent the Commission decides to maintain a productivity adjustment factor, they should use the proper one. Dr. Christensen's study produces an appropriate productivity factor.

The methodology of the Christensen study is the same that I would use if I were to do an independent study and analysis of the telecommunications industry. Based upon my knowledge and respect of the individuals performing the study and based upon my review of the study, I have the highest confidence in and agree with the results reported in the Christensen study.

Q. You previously stated that the Christensen study uses the correct methodology for measuring input and output changes. What is the correct way of measuring these changes?

A. The Christensen study uses GDPPI as the output price adjustment factor, and does not use a similar adjustment of the input prices. This is appropriate. Since the telecommunications industry competes on the competitive market for labor, materials and equipment, and since this equipment is produced in competitive markets, the relevant price index is the overall United States market input price index. Thus, there is no differential between local exchange carrier input prices and overall United States economy input prices that needs to be reflected. Tests performed by the Christensen study and parallel tests performed by National Economic Research Associates ("NERA") showed no evidence of a long run deviation in the series of input prices between the

telecommunications industry and the United States economy.

Q. What is the issue with regard to comparing the inflation faced by telephone companies in their input prices, versus the inflation that occurs in the general economy?

A. This issue has been raised by some parties in other proceedings, and we anticipate that it may also be raised here. Typically, the claim is something like the following: (1) the prices of the inputs that local telephone companies buy face inflation at a lower rate than the general rate of inflation in the economy; so (2) using an economy-wide inflation index for the price cap gives local telephone companies too much of an inflation adjustment; so (3) regulators should increase the productivity offset to adjust for this claimed difference.

Q. What is the problem with this claim?

A. It is simply wrong, in at least two senses. First, as a matter of fact it is not true that what telephone companies buy is subject to less than average inflation. Second, even if it were true, the suggested remedy is wrong--because in such an unusual situation, the economy would adjust to reduce the gap (which is to say, the purported benefit in this example) so that local telephone companies would never get the opportunity of keeping this claimed differential as extra profits.

Q. What needs to be done to test whether the labor, goods and services that local telephone companies buy are facing inflation at an unusually low (or high) rate?

A. To test this, we need to look at what is called a price series, which is a set of data developed to show what the prices actually were for the purchase of certain types of goods and services over a period of time. For this analysis we need two price series--the one for the inputs local exchange carriers buy, and the one for the United States economy as a whole. We can then perform a battery of standard statistical tests to compare the two price series, and to see whether they are the same, or different.

Q. If the two price series are the same, would you expect to see identical values for each time period?

A. No, you would not. Random statistical fluctuations are to be expected, which will make the two sets of data somewhat different. However, if the two price series are the same, then over time you would expect those fluctuations to even out.

Q. What would happen if the telecommunications input prices grew at a rate faster than the economy as a whole?

A. This is an area where economists have a very good analysis to describe what might happen in the event that telecommunications input prices were deviating from the general economy as a whole, which, as I have already demonstrated, they are not. But just to complete the analysis, I will describe what would happen if for some reason this was the case.

Essentially, if input prices were to deviate in this fashion for one sector of the economy, the economy as a whole

would adjust to make that deviation smaller and eventually cause it to disappear.

If telecommunications input prices grew at a rate faster than the economy as a whole capital and labor would migrate to telecommunications. This would depress prices in the telecommunications market and increase them in the United States market as a whole, thus closing the gap.

Similarly, if telecommunications prices grow more slowly than the United States economy as a whole, labor and capital migrates out of the industry. This would increase prices in telecommunications while depressing the prices in the economy as a whole, thus again decreasing any gap. A persistent gap is inconsistent with what we know about both labor and capital markets. The market tends to make similar jobs in the labor market have similar wages. The same is true in equipment markets: Electric motors used in telecommunications cost the same as those in shipping. The computer chips running a Class-5 telecommunication switch cost as much as the same chips monitoring the heating and cooling system in a manufacturing plant. A Pentium sold to GTE costs the same as a Pentium sold to General Motors.

Economists speak of such series that move together as being cointegrated and while they may differ in short run fluctuations, over time, they behave in a similar fashion.

Q. Have you run any tests of your own to confirm the results of the Christensen study?

A. Yes. I ran a very simple cointegration test between

the local exchange carrier input price growth series used in the Christensen study and the LEC-United States price series used in the recent FCC price cap proceeding (CC Docket No. 94-1, Appx. F), as well as performing standard Autoregressive Integrated Moving-Average ("ARIMA") analyses on each of the series and the difference between the series.

Q. What can you conclude from your test?

A. Based upon my test, I conclude that the input series are cointegrated. There is no evidence to support the contention that the telecommunications input price series moves differently than the United States input series except for spurious random fluctuations which can be disregarded as I explain below. My calculations appear in Attachment A.

Additionally, rather than merely performing a simple means analysis or regression analysis of the types used by Christensen and NERA, I also performed a complete ARIMA analysis of the difference between the input price series as well as the input price series themselves. My findings support those of the Christensen study, as well as those of NERA. First, there is no evidence the series differ in mean. This means they behave the same way in the long run. Second, the local exchange carrier price input series is quite a bit more volatile than the United States input price series. Third, the only differences between the series are the result of totally random zero-meaned noise.

Q. What do such findings mean?

A. They mean that there is no long run deviation

between the growth in the local exchange carrier input price index and the United States economy input price index. Thus, the Christensen study is correct in not adjusting for spurious deviations in an input price series.

Q. Does the productivity factor set forth in the Christensen study include a "stretch" element like that which exists in the Commission's current productivity factor?

A. No.

Q. Is the use of a "stretch" in a productivity factor appropriate in today's environment?

A. No, it is not. A "stretch" factor is merely an arbitrary extension of a productivity factor. In a competitive environment, a productivity factor is undesirable in itself and places an asymmetric burden on the LECs. To place an extra "stretch" on an already burdened LEC has the potential to severely (and perhaps irreparably) harm a LEC.

Q. Does this conclude your testimony at this time?

A. Yes.

ATTACHMENT A

NRF REVIEW

ARIMA Procedure

Correlations of the Estimates

Parameter	MU	AR1,1	AR1,2
MU	1.000	-0.001	0.010
AR1,1	-0.001	1.000	-0.089
AR1,2	0.010	-0.089	1.000

NRF REVIEW

ARIMA Procedure

Autocorrelation Check of Residuals

To Lag	Chi Square	DF	Prob	Autocorrelations					
6	7.67	4	0.105	-0.011	-0.001	-0.096	-0.098	-0.133	-0.381
12	8.91	10	0.541	0.109	0.061	0.085	0.047	0.018	0.036
18	12.61	16	0.701	-0.015	-0.057	0.075	-0.038	-0.204	-0.016
24	18.52	22	0.674	-0.061	0.130	-0.042	0.088	0.155	-0.052

ARIMA Procedure

Model for variable DIFF

Estimated Mean = 0.61139021

Autoregressive Factors
Factor 1: 1 - 0.10146 B**(1) + 0.14159 B**(2)

NRF REVIEW

OBS	YEAR	USPRICE	TELECOM	DIFF
1	1960	1.7	2.4	-0.7
2	1961	2.9	4.0	-1.1
3	1962	4.5	3.1	1.4
4	1963	3.9	4.9	-1.0
5	1964	5.4	2.4	3.0
6	1965	4.4	2.4	2.0
7	1966	5.5	1.5	4.0
8	1967	2.8	5.0	-2.2
9	1968	6.4	6.1	0.3
10	1969	4.0	2.7	1.3
11	1970	3.2	4.0	-0.8
12	1971	6.6	6.5	0.1
13	1972	6.0	7.6	-1.6
14	1973	8.6	6.6	2.0
15	1974	4.2	4.8	-0.6
16	1975	8.5	9.3	-0.8
17	1976	9.2	9.2	0.0

NRF REVIEW

OBS	YEAR	USPRICE	TELECOM	DIFF
18	1977	7.3	4.80	2.50
19	1978	7.0	7.30	-0.30
20	1979	7.7	2.90	4.80
21	1980	7.0	6.90	0.10
22	1981	9.5	11.00	-1.50
23	1982	3.1	9.30	-6.20
24	1983	6.2	13.70	-7.50
25	1984	6.5	1.80	4.70
26	1985	4.0	0.13	3.87
27	1986	3.8	1.31	2.49
28	1987	3.2	1.71	1.49
29	1988	4.6	-3.21	7.81
30	1989	4.2	-3.68	7.88
31	1990	4.3	11.89	-7.59
32	1991	2.9	1.35	1.55
33	1992	5.1	4.45	0.65

NRP REVIEW

ARIMA Procedure

Name of variable = USPRICE.

Mean of working series = 5.278788
Standard deviation = 2.004352
Number of observations = 33

Autocorrelations

Lag	Covariance	Correlation	-1 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 1
0	4.017429	1.00000	|**********|
1	1.252282	0.31171	|******. |
2	1.591111	0.39605	|******** |

"." marks two standard errors

NRF REVIEW

ARIMA Procedure

Inverse Autocorrelations

Lag	Correlation	-1 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 1
1	-0.12097	| . **| . |
2	-0.28711	| .******| . |

Partial Autocorrelations

Lag	Correlation	-1 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 1
1	0.31171	| . |******. |
2	0.33105	| . |******* |